

## APPENDIX L

### ASSESSMENT OF PREFERRED COOLING-WATER ALTERNATIVE\*

#### L.1 OBJECTIVE

The purpose of this appendix is to present a detailed, "standalone" assessment of the preferred cooling-water mitigation alternative supplementing the material in Section 4.5.

The preferred cooling-water alternative of the Department of Energy is to construct a 1000-acre lake before L-Reactor resumes operation, to redesign the reactor outfall, and to operate L-Reactor in a way (i.e., reduced reactor power when necessary) that assures a balanced biological community in the lake as specified in an NPDES permit to be issued by the State of South Carolina. The impacts from the 1000-acre lake are bracketed by the impacts from the 500-acre lake and the 1300-acre lake described in the Draft EIS.

The lake will require an anticipated minimum period of 3 to 5 years to establish and develop a balanced biological community. Initially, L-Reactor will be operated to maintain 32.2°C or less in about 50 percent of the lake. Studies will be conducted to confirm the biological characteristics and the cooling effectiveness of the lake. Following the results of these studies, L-Reactor operations will be adjusted as necessary to assure the continued maintenance of a balanced biological community.

In the Draft EIS issued in September 1983, the Department of Energy reviewed and evaluated specific cooling-water alternatives for L-Reactor. Based on the comments submitted during the public review and comment period, the Department has expanded the discussion of potential cooling-water alternatives in this Final EIS. Specifically, Section 4.4.2 now provides detailed discussions of additional combinations of engineered cooling-water systems and additional cooling-lake alternatives. The Department has also evaluated each alternative for attaining the thermal discharge standards of the State of South Carolina.

This review included new data from the U.S. Army Corps of Engineers, stating that they could complete construction of a lake on Steel Creek as large as 1000 acres within 6 months on an expedited basis. On this basis, DOE selected the 1000-acre cooling lake as its preferred cooling alternative for the L-Reactor restart because it would:

1. Meet all state and Federal regulatory and environmental requirements, substantially reducing or eliminating thermal impacts on the river, swamp, and unpounded stream, while providing a productive balanced biological community within the lake.
2. Provide the earliest reactor startup and the maximum plutonium deliveries of any environmentally acceptable cooling-water alternative meeting regulatory requirements.

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\*Because this appendix is new, it does not require vertical change bars.

3. Have the lowest costs of any environmentally acceptable cooling-water alternative meeting regulatory requirements.
4. Be amenable to backfitting with precooler systems, if needed, which could improve reactor operational flexibility and the production capability.

Under the Atomic Energy Act of 1954, the Department of Energy is responsible for developing and maintaining the capability to produce all defense nuclear materials required for the U.S. weapons program. The requirements for defense nuclear materials are contained in a classified document--the Nuclear Weapons Stockpile Memorandum--that is approved by the President. In the development of this memorandum, many factors are considered, including the needs of the armed services; the current status of legislative actions on weapons systems and production capability; and the current status of material inventory, material supply from weapon retirements, material production, and weapons fabrication.

The additional requirements for plutonium are contained in the Nuclear Weapons Stockpile Memorandum for fiscal years 1984 through 1989 approved by President Reagan on February 16, 1984. This current Nuclear Weapons Stockpile Memorandum defines the annual requirements for defense nuclear materials for 5 years (fiscal years 1984 through 1989), the planning directives for the next 5-year period, and 5 additional years of projections for long-range planning. In his approval of this Stockpile Memorandum, President Reagan emphasized the importance of meeting these annual requirements and maintaining an adequate supply of defense nuclear materials by directing that: "As a matter of policy, national security requirements shall be the limiting factor in the nuclear force structure. Arbitrary constraints on nuclear materials availability shall not be allowed to jeopardize attainment of the forces required to assure our defense and maintain deterrence. Accordingly, DOE shall . . . assure the capability to meet current and projected needs for nuclear materials and . . . restart the L-Reactor at the Savannah River Plant, Aiken, S.C., as soon as possible."

The specific need for L-Reactor is supported by quantitative analyses of the production capabilities of DOE facilities and the requirements set forth in the Nuclear Weapons Stockpile Memorandum. This information is classified in accordance with the Atomic Energy Act of 1954. A classified appendix to this EIS (Appendix A) provides a quantitative evaluation of the need for L-Reactor based on the latest approved Nuclear Weapons Stockpile Memorandum. The quantitative analysis in Appendix A supports the need to restart L-Reactor as soon as practicable.

Pursuant to Federal regulations on the discharge of dredged or fill material into navigable waters (40 CFR 230), several other alternatives were identified and discussed in Section 4.4.2 "which would have less adverse impact on the aquatic ecosystem" (40 CFR 230.10a). These included the recirculating alternatives and the once-through cooling tower with a separate canal and pipe to the Savannah River. None of these alternatives can be implemented in time to meet the need for nuclear materials, and all are more expensive and would delay reactor startup significantly. These alternatives were, therefore, rejected as impracticable when considered "in light of overall project purpose" (40 CFR 230.10a2); i.e., developing and maintaining the capability to produce defense nuclear materials required for the U.S. weapons program.

The primary contenders of the 1000-acre lake alternative are recirculating mechanical-draft cooling towers of the type described in Section 4.4.2.3.2. The best of these towers is, thus, the "best available technology." For purposes of life-cycle comparison, the 1000-acre lake is assumed to cost about \$25 million; allow a reactor startup of February 1, 1985; and require an initial (averaged) reactor power reduction of 14 percent, which can be reduced to about 3 percent by February 1, 1987, by the expenditure of approximately \$10 million for pre-coolers to improve lake performance. Similarly, it is assumed that the most efficient 2.8°C approach towers are used, which would cost from \$60 to \$75 million to construct (depending on blowdown treatment), allow a reactor startup of September 1986, and require a reactor power reduction of 6.5 percent (Grandall, 1984).

The life-cycle cost of the 1000-acre lake (i.e., construction, operation, and loss of production including the later startup of the cooling tower) is almost three times less than that of the recirculating cooling tower; this large advantage will persist over any other cooling alternative that meets current regulatory criteria.

The preferred alternative (1000-acre lake) can meet the State of South Carolina criteria and be implemented in the shortest time period to allow DOE to restart L-Reactor as soon as possible.

Although the preferred alternative may have more adverse impacts to the aquatic ecosystem than some of the alternatives discussed in Section 4.4.2, the Department of Energy has committed to initiating several additional mitigation measures to offset any potential adverse impacts for the preferred alternative:

- Funding long-term studies to assure a balanced biological community in the lake and downstream from the embankment.
- Developing a monitoring and mitigation plan for historic/archeological sites to ensure the preservation of the resources at the four sites below the embankment; the plan has been approved by the South Carolina State Historic Preservation Officer (SHPO) (Du Pont, 1983a). A resource recovery plan has been developed by the University of South Carolina Institute of Archeology and Anthropology for the one historic site (38 BR 288) located within the proposed lake area. This mitigation plan has been approved by the SHPO and the Advisory Council on Historic Preservation (ACHP) (Lee, 1982), which concurred that this mitigation plan will result in no adverse impacts to National Register properties. Archeological surveying and testing are presently being conducted in the proposed lake area by the University of South Carolina, Institute of Archeology and Anthropology. It is anticipated that several sites associated with the Ashley Plantation will be affected. The schedule for completion of the requirements under the National Historic Preservation Act, including data recovery, is consistent with the construction schedule for the embankment, and all mitigation will be completed prior to restart (Hanson, 1984). The study results, the determination of eligibility of potential sites, and the development of a mitigation plan are being coordinated with the SHPO and ACHP.

- Working with the Department of the Interior to perform a Habitat Evaluation Procedure (HEP). The HEP will identify the value of habitat to be gained or lost with implementation of the preferred cooling-water mitigation alternative for use in assessing further mitigation. If required, DOE will implement additional mitigative measures that might be identified through the HEP process, dependent on Congressional authorization and appropriation.
- The endangered wood stork forages at the Savannah River Plant but does not breed on the site. The feeding individuals have been observed to be from the Birdsville Rookery, some 50 kilometers away. Feeding occurs in the swamp downstream of the proposed lake; it could be affected by raised water levels of the Steel Creek delta if the L-Reactor cooling-water flow is discharged through the proposed lake. DOE initiated informal consultation with the U.S. Fish and Wildlife Service (FWS) in July 1983 as allowed by Section 7 of the Endangered Species Act. DOE has also initiated the formal consultation process by providing a Biological Assessment to FWS for a Biological Opinion (Sires, 1984a). While DOE concludes that the operation of L-Reactor will affect foraging habitat near the Steel Creek delta, the construction activities associated with Phase II of the NPDES permit to control the acidity of releases from the 400-area powerhouse ash basins will improve the quality of the foraging habitat in the Beaver Dam Creek area, assuring the continued availability of this habitat. Therefore, the loss of foraging habitat in the Steel Creek area should not jeopardize the continued existence of the wood stork. Any additional mitigation measures needed will be determined either as part of the HEP study or as part of this consultation process. DOE will also continue to fund long-term studies of the wood stork and its relationship to SRP.
- The 1000-acre lake construction activity would include an Environmental Protection Plan (see Section L.2.4.8.3).
- Construction of the lake will include shoreline refuge areas to enhance the biological productivity of the lake.

In accordance with Section 313 of the Federal Water Pollution Control Act, the 1000-acre cooling lake was compared with "innovative treatment processes and techniques" (e.g., thermal cogeneration). As discussed in Section 4.4.2.5.1, the costs of these innovative treatment processes would be significantly higher than those of the 1000-acre lake, would require as long as 12 years to implement, and would not meet State of South Carolina standards. Thus, these alternatives were considered impracticable in terms of cost, schedule, and compliance with standards to meet the overall project purpose.

The preferred alternative will meet the South Carolina standards within the necessary time frame to fulfill the need for nuclear materials. Thus, the preferred alternative with the implemented mitigation measures to offset adverse impacts constitutes the most practicable alternative to meet the overall project purpose.

## L.2 SUMMARY

The preferred cooling alternative proposed for mitigating thermal impacts on Steel Creek and swamp is to form a 1000-acre cooling lake by constructing an embankment across Steel Creek (Figure L-1).

### L.2.1 Description

The description in the following sections is representative of the lake design, but the detail is not exact (e.g., embankment dimensions) because the final design has not been completed.

#### L.2.1.1 Lake

The 1000-acre lake would be about 1200 meters wide at its widest point, averaging approximately 600 meters, and would extend about 7000 meters along the Steel Creek valley from the embankment to just beyond Road B (Figure L-2). The normal pool elevation of the lake would be 58 meters above mean sea level (MSL); the present elevation of Steel Creek at the dam site is 35 meters. The storage volume at the normal pool elevation would be about 31 million cubic meters.

#### L.2.1.2 Embankment

The embankment would be approximately 800 meters upstream from the Seaboard Coast Line Railroad Bridge across Steel Creek or 1700 meters upstream from Road A. It would be 1200 meters long at the crest which includes approximately 600 meters of low embankment connecting the west end of the main embankment to the natural ground at elevation 61 meters above mean sea level (Figure L-3). The main embankment would be a maximum of about 26 meters high, 12 meters wide at the top, and 200 meters wide at the base. The elevation at the top of the embankment would be 61 meters above mean sea level to allow 3 meters freeboard for flood pool, wave action, and earthquake settlement.

A paved road would be constructed along the top of the embankment to provide access for operation and maintenance. An outlet structure with gates would control the discharge from the lake to a conduit running 220 meters under the embankment. This conduit would discharge into a stilling basin to reduce the velocity before the water is released into Steel Creek.

A natural "saddle" in the ridge line between Steel Creek and Pen Branch watersheds is the lowest point in the drainage divide around the lake. This area, which has a low-point elevation 60 meters above mean sea level, would function temporarily as an emergency spillway to bypass extreme floods and prevent overtopping of the embankment. An engineered spillway would be constructed at a later date.

### L.2.1.3 Relocation of existing facilities

The construction of the 1000-acre lake would require the relocation of a 115-kilovolt electric transmission line belonging to the South Carolina Electric and Gas Company (SCE&G) and two 115-kilovolt electric transmission lines and buried supervisor control and relay cable lines that serve the L- and P-Areas. The SCE&G line can be raised from existing wooden poles onto two new tall towers in its present alignment. However, the two SRP lines would have to be rerouted around the lake because of the buried cable and the width of the lake at those points. Also, two new SCE&G transmission lines presently being designed by that company will be constructed such that they will not interfere with the 1000-acre lake.

Road A-14 would be abandoned wherever it would become inundated by the lake. The access road across the embankment would begin at Road A west of the lake and be extended northeast from the east end of the embankment along a ridge to connect with Road A-14 east of the lake. This road would parallel one of the relocated SRP transmission and buried cable lines. Approximately 600 meters of Road B and 100 meters of Road C would be raised a maximum of 3 meters on their existing roadbeds at their intersection.

## L.2.2 Operation

### L.2.2.1 Thermal modeling

The thermal performance of the 1000-acre lake was estimated from a state-of-the-art mathematical model (Firstenberg and Fisher, 1980). The model calculates downlake temperatures for a laterally well-mixed water body (due to the long, narrow shape of the lake, total lateral mixing is a good assumption) given the shape of the lake, lake influent information (flow rate, temperature), and meteorological data (wind speed, air temperature, cloud cover, relative humidity, and time of year). The input information can be either constant or time dependent. The model has been verified by comparison with the temperature distributions of a number of operating cooling ponds.

For this analysis, 30 years of hourly meteorological data (1953-82) from Bush Field in Augusta, Georgia, were used in conjunction with monthly SRP reactor operating power levels to perform hour-by-hour simulations of lake temperature. The results of the study are described below.

### L.2.2.2 Lake influent

L-Reactor will be operated at the highest allowed power level that is consistent with the maintenance of the balanced biological community in the lake, as specified in the NPDES permit that is expected to be issued by the State of South Carolina. Initially, L-Reactor will be operated to maintain 32.2°C or less in about 50 percent of the lake. Adjustments of reactor power levels will be based on near-term (several days in the future) meteorological predictions and the existing lake temperature distribution. Hourly meteorological data for the years 1953 through 1982 and the cooling-lake thermal performance model

described in Section L.2.2.1 were used in an iterative fashion to determine reactor power levels that would be required to meet the above temperature criterion. The resulting average reactor power reduction was approximately 7 percent. For the life-cycle cost comparison in Section L.1, the average power reduction was increased to 14 percent to provide a sufficient margin in relation to the temperature criterion, due to the fact that reactor power levels will be based on predictive meteorology, and in recognition of the fact that frequent reactor power changes would also be restricted by considerations other than the thermal criterion.

#### L.2.2.3 Lake temperatures

As indicated in Section L.2.2.2, the plant will be operated in a manner such that the temperature of the water covering about 50 percent of the lake would not be greater than 32.2°C. Although the exact operating mode of the plant will depend on production schedules and meteorological conditions, the lake performance based on power levels determined in the iterative method discussed in the previous section will be used to represent the expected monthly temperature distributions in the lake. Figures L-4 through L-7 indicate the percentage of the lake surface area having a given temperature for each season of the year. (Note: In this analysis, winter is defined as December, January, and February; spring is March, April, and May; summer is June, July, and August; and fall is September, October, and November.) As can be seen from these figures, the water temperature of the coolest 50 percent of the lake ranges from 23° to 17°C in winter (with some months of the 30-year data base implying temperatures as low as 20°C to 14°C) and 32° to 31°C in summer.

Figures L-8 through L-11 show the estimated isotherms in the 1000-acre lake at a depth of approximately 1 to 2 meters. The shaded areas represent areas in the lake that will be below 32.2°C for each season, after accounting for reduced reactor operating power. An auxiliary flow model was used in conjunction with the lake temperature graphs presented in Figures L-4 through L-7 to derive these isotherm shapes. The actual distribution of lake water temperatures will vary from the isotherm representation shown in Figures L-8 through L-11. This variation will occur because of transient wind effects and water density differences.

The heated water being discharged into the lake would spread over the cooler water residing in the lake. This surface layer would tend to exist throughout most of the lake due to the relatively small advective transport of the discharge, the depth of the lake, and the large temperature difference (between the influent and the effluent) within the lake. In addition, the discharge into the lake would be accomplished so that mixing of the discharge and resident lake water would be kept low (a desirable condition to maximize the heat flux through the water surface). Based on observations in Par Pond, as well as theoretical considerations, the surface layer in the L-Reactor cooling lake is expected to be a few feet thick. This layer would be vertically well mixed due to wind-induced turbulence. A cooler sublayer would exist beneath the surface layer. This layer would be fed by lake water returning from the cold end to satisfy the continuity requirements of discharge mixing and lake withdrawal. Accordingly, the temperatures in the deeper portions of the lake would approximate the cold end temperatures. That is, the colder sublayer temperature

would range between approximately 17° and 31°C throughout the year (although some winter temperatures might be as low as 14°C, as inferred from the 30-year data base).

#### L.2.2.4 Lake operation

During construction of the embankment, streamflow would be carried through the work area in a temporary metal conduit laid parallel to the outlet works conduit. An upstream cofferdam, with a crest at elevation 43 meters above mean sea level, would divert the water into the metal conduit and protect the work site. A low downstream cofferdam would protect the site from rising tailwater. This diversion configuration would provide protection from a storm with a recurrence interval of between 25 and 50 years.

Following completion of the reconfigured discharge canal, outlet works and embankment, the outlet gates would be closed and the pool elevation of the lake would be allowed to rise to the design elevation of 58 meters above mean sea level. Assuming a constant inflow of about 11 cubic meters per second of Savannah River water from L-Reactor, 0.45 cubic meter per second from P-Reactor, and 0.62 cubic meter per second Steel Creek base flow, approximately 30 days would be required to fill the lake. As impoundment of the lake occurred, the response of the embankment would be monitored to verify design. Flow would be maintained down Steel Creek below the embankment during filling. Lake filling would be completed before startup of L-Reactor.

Cooling water and lake discharge flows would be managed to maintain a balanced biological community in the lake and in Steel Creek and swamp. Reactor cooling-water flow variations and lake discharge management would restrict water level fluctuations to assure a healthy aquatic macrophyte population in the lake. The development of shoreline refuge areas also would enhance this macrophyte population, which would provide the necessary habitat for growth and reproduction of certain fish and macroinvertebrates necessary to maintain a balanced biological community (see Section L.4.1.1.2).

Downstream flows would be maintained constant throughout reactor operating periods, except during periods of extreme rainfall. During short reactor outages occurring within the spring spawning period, the flow at Road A would be controlled to about 3 cubic meters per second, thereby maintaining good spawning habitat. The remainder of the year, flow in Steel Creek at Road A during shutdown periods would maintained at about 1.5 cubic meters per second, providing opportunities for fish to move freely from the base of the embankment to the Savannah River Swamp.

If long reactor outages should occur during the spawning period, flow would be maintained at a rate of about 3 cubic meters per second. For long outages at other times, only base flow conditions would occur in Steel Creek.

### L.2.3 Design bases

#### L.2.3.1 Design flood

The embankment and its outlet works would be designed for the U.S. Army Corps of Engineers' "Standard Project Flood." The Standard Project Flood is the flood that can be expected from the most severe combination of meteorologic and hydrologic conditions that are considered reasonably characteristic of the region. It was established by the Corps of Engineers as a practicable expression of the degree of flood control works for situations that involve the protection of human life and high-value property.

Because the Standard Project Flood is developed from extreme hypothetical conditions, it cannot be assigned a specific recurrence interval. [A recurrence interval is defined as the average interval in years between the occurrence of a flood of specified magnitude and an equal or more severe flood (Linsley and Franzini, 1979).] A recurrence interval of a few hundred to a few thousand years is commonly associated with the Standard Project Flood.

At the site, the Standard Project Flood is a 96-hour storm of varying intensity that produces a total rainfall of 51 centimeters. Figure L-12 compares this storm with the precipitation-frequency characteristics of the area. The figure shows the maximum depth of rainfall for various durations and recurrence intervals. The maximum depth of rainfall for the design storm is superimposed on this. The design storm exceeds the 100-year storm for all durations. The dotted lines are extrapolations of the published precipitation-frequency data. They provide an indication of the design storm's recurrence interval for various durations. For example, the 96-hour duration, 51-centimeter depth corresponds to a recurrence interval of more than 10,000 years. The response time of the 1000-acre lake's watershed is such that durations in the 2- to 6-hour range are the most significant. In this range, the storm's recurrence interval varies from about 1000 to 40,000 years. Section L.3.4.1.3 describes the results of the computer analysis of the Standard Project Flood on Steel Creek.

An even rarer flood, the probable maximum flood (PMF), was also included in the design bases. This flood is the result of a 72-centimeter rainfall in 24 hours. The principal outlet works and existing natural emergency spillway (see Section L.2.3.3) are capable of controlling the PMF.

#### L.2.3.2 Seismic analyses

Seismic considerations would be included in the design of the foundation, embankment, and outlet works. Sand and gravel filters would be installed to dissipate pore pressures and heal possible cracking resulting from a seismic event. To reduce the effect of seismic-induced deformation, the embankment design would incorporate a wide crest, intermediate berm, and flat slopes. Analysis of the liquefaction potential of the foundation would be evaluated for any needed improvements. Detailed seismic analyses have not been performed, but the embankment design will include appropriate seismic considerations. The consequences of the unlikely event of embankment failure are discussed in Section L.4.2.2.

#### L.2.3.3 Other design criteria

The outlet works would consist of a vertical intake tower with multilevel gates, a concrete conduit, and a stilling basin. These works would be designed to pass the L-Reactor cooling-water flow, the service-water flow from P-Reactor, and the natural base flow, while holding the lake elevation at 58 meters above mean sea level. They would also serve as the principal flood-control outlet designed to be fully capable of controlling the standard project flood.

In the extremely unlikely event of a flood that is more severe than the standard project flood, overtopping of the embankment would not occur. A natural saddle would serve as an emergency spillway and divert flow to Pen Branch. This saddle has an elevation of about 60 meters at its low point and spans 183 meters at the top of the embankment elevation of 61 meters. The probable maximum flood (PMF) would result in a maximum pool elevation between the low point of the saddle and the top of the embankment. Section L.3.4.1.3 describes the results of the computer analysis of the PMF on Steel Creek.

#### L.2.4 Construction

##### L.2.4.1 Relocation of existing facilities

SCE&G would design and relocate its own transmission lines. The design and construction of the relocation of the SRP roads and transmission and control cable lines would be performed by the Du Pont Engineering Department. The U.S. Forest Service would administer all clearing for these relocations as well as for the lake area.

##### L.2.4.2 Site preparation

###### L.2.4.2.1 Clearing

All areas upstream from the embankment and less than 58 meters above mean sea level would be cleared of second growth pine and hardwood to provide for the 1000-acre lake area. All marketable timber from this area and from the road and transmission corridors would be cut, removed, and sold under the supervision of the U.S. Forest Service. Timber and vegetation in any area flooded by Steel Creek waters since 1954 might contain low-level radioactivity and would not be marketable. Procedures for the removal and disposition of such material would be developed and approved before construction started. Underbrush and scrap from timber cutting outside the area flooded by Steel Creek since 1954 except around some of the shoreline area would be piled and burned. Stumps would be removed under all embankment areas but not from the area within the lake.

###### L.2.4.2.2 Foundation preparation

Areas to be covered by the embankment, inlet and outlet works, or roadways would be grubbed and stumps would be removed and burned. All topsoil would be

stripped and stockpiled for use on the finished grade for turf establishment. It could be necessary to excavate unconsolidated sediments from the area under the dam to a depth of between 3 and 15 meters to expose a tight clay formation to which the embankment could be sealed. Approximately 600,000 cubic meters of unsuitable material could be removed from the embankment site before 1.2 million cubic meters of borrow fill and rip-rap would be placed to form the embankment. Spoil from the surface portion of the embankment foundation in the Steel Creek floodplain, estimated to contain a total of 0.2 curie of cesium-137 and 0.02 curie of cobalt-60, would be separated, contained, replaced outside the jurisdictional wetlands upstream of the embankment, and covered with subsurface spoil to prevent erosion during the construction period. ["Jurisdictional wetlands" are those areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (33 CFR 323.2c).] This relocation would have no effect on net cesium transport estimates. All other material would be removed and used for backfill in the borrow areas.

#### L.2.4.2.3 Abandoned well survey and sealing

Research is currently underway to determine how many wells were constructed within the lake area before Government acquisition of the SRP property. All of these wells would be sealed before the lake begins filling to reduce the chance of affecting ground-water quality.

In March 1984, a survey team from the Furman University Department of Geology performed a field survey of this portion of the Steel Creek watershed. Twenty old possible well sites were identified in this area, 11 of which were found to lie within the boundaries of the 1000-acre lake. The sites vary from shallow open depressions to deep-cased and screened wells. Several of these might be grave sites or archeological sites rather than wells.

Each site identified, as well as any others drilled or located during construction of the 1000-acre lake, would be sealed by filling from bottom to top with sand-cement or concrete in accordance with the South Carolina Primary Drinking Water Regulations, Section R-61-58.2 C (14) "Permanent Well and Test Hole Abandonment." All information relative to each site (e.g., exact plant coordinate location, depth, diameter) would be recorded and submitted to SCDHEC.

#### L.2.4.3 Earthwork and other civil construction

##### L.2.4.3.1 Embankment construction

The embankment would be of rolled earth construction, excavated from borrow areas nearby or within the lake area, and transported with standard earth-moving equipment. The interior of the embankment would be divided into impervious zones and drainage zones to provide internal and foundation drainage, relieve pore pressures, and heal possible cracking resulting from a seismic event. Piezometers would be installed during construction and permanent instrumentation to monitor embankment performance would be included as part of the design.

The design would limit the embankment slopes from 3 to 4 meters horizontally for each meter of height (Figure L-13). Flat berms might be required on both faces partway up the slopes. The exposed portion of the upstream slope would be protected against erosion caused by variations in water level and wave action by rip-rap on a gravel filter bedding.

Criteria of embankment stability design have established that seepage of water is a critical consideration. Therefore, the embankment will be designed so that total permanent seepage loss through the embankment abutments and foundation will be limited. To ensure positive restriction through the foundation of the embankment, an impervious soil or grout cutoff trench will be constructed to the maximum depth that is economically feasible and tied into the abutments. Seepage through the embankment will be slight, because the embankment will consist of three or four zones.

#### L.2.4.3.2 Roadway and utility access

An access road would be constructed from Road A approximately 400 meters to the west end of the embankment. This road would become the permanent access to the completed facility for operation and maintenance. Another road would be constructed from Road A-14 east of Steel Creek southwesterly along a ridge to the east end of the embankment. This road would provide a route from the railroad siding at Meyers Mill to the embankment site.

An electric transmission line would run southeasterly approximately 1500 meters from an existing substation near Roads A and A-16. This line would provide 120/208/460-volt electrical power service for lighting, instrumentation, and gate motors. A small building would be required at the embankment to house instruments and controls.

#### L.2.4.3.3 Borrow pit operation

Areas close to the embankment would provide the approximately 1.2 million cubic meters of borrow material necessary to construct the embankment. This material must meet the specifications for the various zones contemplated. Any borrow area outside the limit of the lake would have to be cleared and then regraded; ground cover would have to be established after the borrow material had been removed. Therefore, primary consideration would be given to finding suitable material within the area to be cleared for the lake. By excavating areas at or just above the normal pool elevation, the surface area of the lake could be increased at little additional cost. Some internal drainage material and all riprap material would be brought to the construction site from outside SRP.

#### L.2.4.3.4 Outlet works

The outlet works would consist of a freestanding intake tower with multilevel gates, a concrete conduit and a stilling basin (Figure L-13). The vertical intake tower would be a cast-in-place concrete structure consisting of a flood control passage and two collection wells. A concrete conduit would be used to carry water from the intake tower through the embankment. This conduit would also carry the normal releases from the lake. The outlet works would be fully capable of controlling floods with a recurrence interval of greater than 100 years.

Four to six gates would be installed in the intake tower. One multilevel intake gate would be located in each of two opposing walls of the intake. The invert elevation of these gates would be 54 meters MSL. The two gates would pass about 11.3 cubic meters per second, the normal flow, and be operated in a totally open or totally closed position. Water could enter the discharge structure at a depth of 2 to 4 meters below the surface and/or from near the bottom of the lake. Discharge would be regulated with a service gate located at the bottom of each collection well at the tower invert (at 35 meters elevation). An emergency gate would be located upstream of each service gate to provide a positive cutoff should the service gate fail. A trash rack would be located upstream of the emergency gates to prevent debris from interfering with the operation of the service gates. The gates would be electrically controlled from the service building; provisions would be made for emergency manual operation of the gate.

#### L.2.4.4 Reconfiguration of outfall canal

The existing outfall canal would be completely submerged by the 1000-acre lake, which would have a normal pool elevation of 58 meters above mean sea level. The existing 1.8-meter-diameter discharge pipe has a bottom elevation of 58.5 meters and drops vertically at a concrete headwall to an existing concrete stilling basin at the head of the outfall canal, which has a bottom elevation of 53.3 meters. Therefore some reconfiguration must be accomplished to reduce the 4.3-meters-per-second velocity and 1.8-meter height of the cooling-water flow where it would leave the pipe and enter the lake. Cooling efficiency of the lake would be enhanced by distributing the heated water over as large an area of the lake surface as possible without mixing it with the lower depths of the lake volume.

The design for the most appropriate method for reducing the velocity and distributing the heated effluent over the lake surface would be based on detailed engineering studies. Figure L-14 is an example of one possible configuration. Such a radial discharge design, consisting of radial baffles, would spread the flow momentum uniformly in all horizontal directions, thereby reducing eddying effects. With a properly engineered design, it could be possible to minimize the vertical entrance mixing by creating a stable interface and strongly reducing and horizontal circulations in the vicinity of the discharge.

#### L.2.4.5 Schedule

It was determined that with close coordination and cooperation between DOE and the Corps of Engineers, an expedited schedule could be met. Under the schedule, construction of the 1000-acre lake could be completed in 6 months. This expedited schedule would be possible because the Corps of Engineers has an experienced staff available to design and construct the embankment that would form the lake; this staff is available because it is now completing the construction of the Richard B. Russell Dam on the Savannah River. In addition, the construction does not depend on the procurement of long-lead-time items (i.e., the special-order pumps required for recirculating cooling towers).

#### L.2.4.6 Resource Requirements

##### L.2.4.6.1 Manpower

Approximately 550 workers would be required to construct the 1000-acre lake. These workers would include about 30 civil engineers for design and construction supervision, but would not include current DOE and Du Pont employees who would provide liaison to the construction managers.

Because most of the work in this alternative would be standard civil construction activities such as clearing, earthwork, and the building of minor concrete structures, and because the design includes few mechanical or electrical items, local labor should be able to sustain the level of effort necessary to complete this alternative in a timely manner.

##### L.2.4.6.2 Cost

Capital cost of the project is estimated to be approximately \$25 million, with an annual operating cost of \$3.4 million. The present worth would be \$111 million, and the annualized cost would be \$13.1 million.

#### L.2.4.7 Construction impacts

##### L.2.4.7.1 Historic/archeological

Four historic sites and one prehistoric site in the Steel Creek terrace and floodplain system have been determined to be eligible for inclusion in the National Register of Historic Places. No direct impacts are expected to the prehistoric site or to three of the historic sites because they would be below the embankment and outside the area affected by high-water flow conditions. One historic site area would be inundated when the lake was filled. These sites are shown on Figure L-15. These impacts would be mitigated as described in Section L.2.4.8.1.

In March 1984, an intensive survey of the proposed excavation areas (embankment and borrow pit areas) was made (Brooks, 1984). This survey identified seven sites described as of ephemeral quality and not eligible for nomination to the National Register of Historic Places.

##### L.2.4.7.2 Ecology

There would be two principal sources of potential impact to the ecology of the area: (1) the construction of the embankment and associated appurtenances, and (2) the inundation by the lake.

##### L.2.4.7.2.1 Embankment construction

The construction of the earthen embankment and water diversion system for the lake would cause some temporary increases in suspended solids in Steel Creek. Suitable precautions would be taken (1) during the construction operations necessary to establish a foundation for the embankment, and (2) during

emplacement of the fill to ensure that undue silt and debris loads do not move downstream from the construction site. Turbidity screens could minimize impacts to downstream areas.

Borrow pits for similar quantities of suitable materials have been identified in the past for construction at the Savannah River Plant, and have been controlled in an environmentally acceptable manner. About 90 percent of the fill material for the embankment would probably come from a borrow pit that would be submerged when the lake is filled. A second potential borrow site would not be inundated. A small volume of material might be taken from this location, which would result in the loss of about 5 acres of upland habitat.

The number and routing of access roads for construction have been carefully considered to minimize adverse environmental impacts. An estimated 33 acres of upland habitat outside the area to be inundated would be altered by the construction of access roads. The reconstruction of existing roads would not result in the alteration of any uplands since they would utilize the existing roadbed. The rerouting of powerline and buried cable rights-of-way would cause the loss of an additional 100 acres of upland habitat.

Spoil piles of the size expected for this alternative have been developed for past construction activities at the Savannah River Plant and have met the necessary environmental control requirements. Spoil from any excavation in the former floodplain of Steel Creek would be monitored for radioactive materials; any spoil containing radioactivity would be disposed of as discussed in Section L.2.4.2.2.

#### L.2.4.7.2.2 Inundation of habitats

The filling of the cooling lake would inundate 225 acres of wetlands and 775 acres of uplands in the Steel Creek corridor (approximately 150 acres of "jurisdictional wetlands" as defined by the Corps of Engineers). The vegetation in this area consists primarily of scrub-shrub and forested wetlands. These areas are classified as Resource Category 2 by the U.S. Fish and Wildlife Service. This category and its designation criteria include "high value for evaluation species and scarce or becoming scarce." The mitigation planning goal specifies that there be "no net loss of inkind habitat value" (USDOl, 1981).

#### L.2.4.7.3 Water quality

The potential impacts to water quality from construction would be erosion and sedimentation; these potential impacts would be mitigated as described in Section L.2.4.8.3.

#### L.2.4.7.4 Air quality and noise

About 400 to 550 acres of upland forest would be cleared. Trees of commercial value would be harvested and removed from the site in accordance with the SRP Forest Management Program. Open burning would be employed for disposal of forest slash cleared from the site. Clearing and burning would progress in reasonably sized units of a few acres to minimize local dust and smoke. The nearest roadways to the lake would be SRP Road B (less than 30 meters) and

Highway 125 (1 kilometer). Traffic could be rerouted from Road B if necessary during the burning of slash material. Because of its distance from the construction site, Highway 125 would not be affected. Burning would result in some releases of particulates and gases into the atmosphere, but releases would be local and generally short-lived. Offsite effects are not expected since the nearest location to the SRP site boundary from the lake would be approximately 8 kilometers.

Not all the lake would be grubbed and burned. About 200 acres of lake bottom near the shoreline would be maintained with the stumps in place as habitat for aquatic organisms. Other burnable slash might also be used to construct submerged habitat attraction structures, thus reducing the need to burn all material at the site. Temporary construction roads, laydown areas, and spoil areas would be graded, grassed, wetted, or sprayed with tackifiers as needed to reduce local dust. As much as possible, the roads would be designed to become permanent access roads once the project was completed, thus reducing the impacts of temporary haul roads.

The cooling lake construction site is in a forest area that is relatively remote from human habitation. Noise from construction, primarily from tree-cutting and earth-moving equipment, would have insignificant offsite environmental effect because of the remoteness of the site and the muffling effect of intervening forests. Members of the public using SC Highway 125 would not be in the immediate vicinity of noisy equipment and would have only brief exposure. Effects of this exposure would be insignificant. Noise levels from lake site construction in nearby L-Area, the nearest occupied onsite facility, are expected to be well within clearly acceptable standards (62 decibels). Operators of noisy construction equipment would wear protective equipment in accordance with Du Pont standards (where applicable) and OSHA regulations. Most other workers in the area would be exposed to high noise levels only intermittently, but protective equipment would be provided when the exposure could be expected to be sustained. No impulsive or impact noises in excess of acceptable standards would be expected.

#### L.2.4.7.5 Socioeconomic

The construction of the 1000-acre lake would be completed over a 6-month period at a capital cost of approximately \$25 million and an annual operation cost of \$3.4 million. The present worth of this alternative would be \$111 million and the annualized cost would be \$13.1 million. The construction would require about 550 workers. The potential economic effects on the local economy are expected to be positive; however, these effects will be small (in relation to other ongoing SRP projects--DWPF and FMF) and of short duration (6 months). Impacts to local community facilities and services are expected to be minor because most construction personnel will be hired from within the Central Savannah River Area. Such personnel are presently available because the Richard B. Russell Dam construction is near completion.

#### L.2.4.7.6 Land use

The 1000-acre cooling lake would be entirely within the present SRP area boundaries. Land use within the SRP area would be altered, in that 1000 acres would be inundated to become a cooling lake and the previous land uses as forest land and bottom land would be interrupted. The 1000 acres would include

450-600 acres of wetland in the Steel Creek Corridor and 400-550 acres of up-land. Timber of commercial value would be harvested and removed from the site in accordance with SRP Forest Management Program. An additional area (about 100 acres) would be cleared for road and utility access relocation.

The timber which would be harvested consists of pine saw timber, pine pulp wood, hardwood saw timber, and hardwood pulp wood. Table L-1 summarizes the timber value and annual growth. The anticipated value from harvesting the timber is \$950,000. The annual loss in timber productivity is projected to be \$44,000. This impact is not amenable to mitigation.

Table L-1. Timber value and annual growth

Type of timber	Present Volume/Value			Annual Growth	
	Volume (1000 board feet)	Cords	Value (\$1000)	Volume (%)	Value (\$1000)
Pine, saw timber	5058	--	715	4	28
Pine, pulp wood	--	4326	102	8	12
Hardwood, saw timber	2550	--	128	3	4
Hardwood, pulp wood	--	3384	5	6	.3
Totals	--	--	950	--	44

#### L.2.4.8 Construction impact mitigation

##### L.2.4.8.1 Historic/archeological site mitigation

A monitoring and mitigation plan has been developed to ensure the preservation of the resources at the four sites below the dam, and the plan has been approved by the South Carolina State Historic Preservation Officer (SHPO) (Du Pont, 1983a).

A resource recovery plan has been developed by the University of South Carolina Institute of Archaeology and Anthropology for the one historic site (38 BR 288) located within the proposed lake area. This mitigation plan has been approved by the SHPO and the Advisory Council on Historic Preservation (ACHP) (Lee, 1982), which concurred that this mitigation plan will result in no adverse impacts to National Register properties.

Archeological surveying and testing are presently being conducted in the proposed lake area by the University of South Carolina, Institute of Archeology and Anthropology. It is anticipated that several sites associated with the Ashley Plantation will be affected. The schedule for completion of the requirements under the National Historic Preservation Act, including data recovery, is consistent with the construction schedule for the embankment, and all mitigation

will be completed prior to restart (Hanson, 1984). The study results, determination of eligibility of potential sites, and the development of a mitigation plan are being coordinated with the SHPO and ACHP.

#### L.2.4.8.2 Ecological mitigation

The Department of Energy is working with the Department of the Interior to perform a Habitat Evaluation Procedure (HEP). The HEP will identify the value of habitat to be gained or lost with implementation of the preferred cooling-water mitigation alternative for use in assessing further mitigation. If required, DOE will implement additional mitigative measures that might be identified through the HEP process, dependent on Congressional authorization and appropriation.

The endangered wood stork forages at the Savannah River Plant but does not breed on the site. The feeding individuals have been observed to be from the Birdsville Rookery, some 50 kilometers away. Feeding occurs in the swamp away from the proposed lake; it could be affected by raised water levels in the Steel Creek delta if the L-Reactor cooling-water flow is discharged through the proposed lake. DOE initiated informal consultation with the Fish and Wildlife Service (FWS) in July 1983 and in March 1984 as required by Section 7 of the Endangered Species Act. DOE has also initiated the formal consultation process by providing a Biological Assessment to FWS for a Biological Opinion (Sires, 1984a). While DOE concludes that the operation of L-Reactor will affect foraging habitat near the Steel Creek delta, the construction activities associated with Phase II of the NPDES permit to control the acidity of releases from the 400-area powerhouse ash basins will improve the quality of the foraging habitat in the Beaver Dam Creek area, assuring the continued availability of this habitat. Therefore, the loss of foraging habitat in the Steel Creek area will not jeopardize the continued existence of the wood stork. Any additional mitigation measures needed will be determined either as part of the HEP study or as part of this consultation process.

#### L.2.4.8.3 Water quality mitigation

The lake construction activity would include an Environmental Protection Plan, which would include several measures designed to mitigate water quality impacts.

Earthwork brought to final grade would be protected as soon as practicable. All earthwork would be planned and conducted to minimize the duration of exposure of unprotected soils. Except in instances where the constructed feature obscures borrow areas and waste material areas, these areas would not initially be cleared in total. Clearing of such areas would progress in reasonably sized increments as needed.

Such methods as necessary would be utilized to effectively prevent erosion and control sedimentation, including but not limited to the following:

1. Retardation and control of runoff. Runoff from the construction site would be controlled by construction of diversion ditches, benches, and berms to retard and divert runoff to protected drainage courses.

2. Sediment basins. Sediment from construction areas would be trapped in temporary or permanent sediment basins in accordance with design plans. The basins would accommodate the runoff of anticipated storms. After each storm the basins would be pumped dry and accumulated sediment would be removed as necessary to maintain basin effectiveness. Overflow would be controlled by paved weir or by vertical overflow pipe, draining from the surface. The collected topsoil sediment would be reused for fill on the construction site, and/or conserved (stock-piled) for use elsewhere. Effluent quality monitoring programs would be required.

Temporary erosion and sediment control measures such as berms, dikes, drains, sedimentation basins, grassing and mulching would be maintained until permanent drainage and erosion control facilities were complete and operative.

Borrow areas and spoil-storage areas would be managed to minimize erosion and to prevent sediment from entering nearby water courses or lakes. Temporary excavations and embankments for work areas would be controlled to protect adjacent areas from despoilment.

Solid wastes (excluding clearing debris) would be placed in containers which would be emptied on a regular schedule. All handling and disposal would be conducted to prevent contamination. Chemical waste would be stored in corrosion-resistant containers, removed from the work area, and disposed of in accordance with Federal, state and local regulations.

Construction activities would be kept under surveillance, management and control to avoid pollution of surface and ground waters. The following special management techniques would be implemented to control water pollution: (1) wastewaters from construction activities would not be allowed to leave the site; they would be collected in retention ponds where suspended material could be settled out or the water could be evaporated so the pollutants would be separated; (2) the operation would be planned to minimize adverse impacts of dewatering, removal of cofferdams, and excavation, and to limit the impact of water turbidity on the habitat for wildlife and impacts on water quality for downstream use; (3) stream crossings would be controlled during construction; crossings would allow the movement of materials or equipment that did not violate Federal or state water pollution control standards; (4) all water areas affected by construction activities would be monitored; (5) construction activities would be kept under surveillance, management, and control to minimize interference with, disturbance to, and damage of fish and wildlife.

#### L.2.4.8.4 Air emissions and noise control

The construction Environmental Protection Plan would also require measures to mitigate air emissions and noise. Construction activities would be kept under surveillance, management, and control to minimize pollution of air resources. All activities, equipment, processes, and work performed would be in strict accordance with applicable requirements.

The following special management techniques would be implemented to control air pollution by the construction activities:

1. Dust particles, aerosols, and gaseous byproducts from all construction activities, processing and preparation of materials would be controlled at all times, including weekends, holidays, and hours when work is not in progress.
2. Particulates that could cause the air pollution standards to be exceeded or that could cause a hazard or a nuisance would be controlled at all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas inside or outside the project boundaries. Sprinkling, chemical treatment of an approved type, light bituminous treatment, or other methods would be utilized to control particulates in the work area. Sprinkling would be repeated at intervals to keep the disturbed area damp. Particulate control would be performed as the work proceeded and whenever a particulate nuisance or hazard occurred.
3. Hydrocarbons and carbon monoxide emissions from equipment would be controlled to Federal and State allowable limits at all times.
4. Odors would be controlled at all times for all construction activities, processing and preparation of materials.
5. Air at all areas affected by the construction activities would be monitored.

Construction activities would be kept under surveillance and control to minimize damage to the environment by noise. Methods and devices would be used to control noise emitted by equipment to the levels shown in the COE, Savannah District Safety Manual (COE, 1981a).

### L.3 COOLING-LAKE AFFECTED ENVIRONMENT

#### L.3.1 Geography

##### L.3.1.1 Location

The Savannah River Plant (SRP), including the L-Reactor and the proposed cooling lake, is located in southwestern South Carolina. The Plant occupies an almost circular area of approximately 780 square kilometers, bounded on its southwestern side by the Savannah River, which is also the Georgia-South Carolina border. Chapter 3, Section 3.1 presents the site location in relation to major population centers, the closest being Augusta, Georgia, and Aiken and Barnwell, South Carolina.

#### L.3.1.2 Historic/archeologic sites

During January and February 1981, a survey was conducted of the Steel Creek terrace and floodplain system below L-Reactor for archeological resources and sites that might qualify for inclusion in the National Register of Historic Places (Hanson et al., 1981). The area of Steel Creek surveyed was 13 kilometers long and 300 meters wide. Archeologists traversed the first and second terraces of the creek system, inspecting 4-square-meter plots every 5 meters along the creek.

The survey identified 18 historic and archeological sites along Steel Creek below L-Reactor. One archeological site, located at the confluence of Steel Creek and Meyers Branch, was considered significant in terms of National Register criteria. In July 1982, the DOE requested the concurrence of the Keeper of the National Register on this site's eligibility for nomination to the National Register. The Keeper concurred in this site's eligibility.

Seven additional sites were considered potentially significant in terms of National Register criteria. Three of these sites occur beyond the area of any potential effects from the 1000-acre lake alternative. The remaining four sites include three mill dams that date to the early nineteenth century and an historic roadway across the Steel Creek floodplain. In July 1982, the DOE requested the concurrence of the Keeper of the National Register regarding the eligibility of these sites for nomination to the National Register. The Keeper of the National Register concurred in the eligibility of these four sites for inclusion in the National Register. These sites are potentially affected. The remaining 10 sites were not considered significant.

In March 1984, an intensive survey of the proposed excavation areas (embankment and borrow pit areas) was made (Brooks, 1984). This survey identified seven sites described to be of ephemeral quality and not eligible for nomination to the National Register of Historic Places. DOE has provided this report to the SHPO to receive his concurrence in the conclusion that no eligible sites are located in the impact area.

Archeological surveying and testing are presently being conducted in the proposed lake area by the University of South Carolina Institute of Archeology and Anthropology. It is anticipated that several sites associated with the Ashley Plantation will be affected. The schedule for completion of the requirements under the National Historic Preservation Act, including data recovery, is consistent with the construction schedule for the embankment, and all mitigation will be completed prior to restart (Hanson, 1984). The study results, the determination of the eligibility of potential sites, and the development of a mitigation plan are being coordinated with the SHPO and ACHP.

#### L.3.2 Socioeconomic and community characteristics

Section 3.2 of this EIS provides a summary discussion of all aspects of socioeconomics and community characteristics in the SRP areas. Additional information on these topics can be found in the Socioeconomic Baseline

Characterization for the Savannah River Plant Area, 1981 (ORNL, 1981) and the Final Environmental Impact Statement, Defense Waste Processing Facility, Savannah River Plant, Aiken, South Carolina (DOE, 1982a). The impacts of the 1000-acre lake would be related primarily to jobs in connection with the construction.

### L.3.3 Geology and seismology

#### L.3.3.1 Geology

##### L.3.3.1.1 Geologic setting

The L-Reactor cooling lake would be located in the Aiken Plateau physiographic division of the Upper Atlantic Coastal Plain of South Carolina (Cooke, 1936; Du Pont, 1980a). Figure 3-5 shows that the topography in the vicinity of the L-Reactor site at the Savannah River Plant is characterized by interfluvial areas with narrow, steep-sided valleys. The relief in the region of the cooling-lake embankment site measures about 56 meters.

The proposed site for the cooling-lake embankment is about 40 kilometers southeast of the Fall Line (Davis, 1902) that separates the Atlantic Coastal Plain physiographic province from the Piedmont physiographic province of the Appalachian region (Appendix F, Figure F-1). Crystalline rocks of Precambrian and Paleozoic age underlie the gently seaward-dipping Coastal Plain sediments of the Cretaceous and younger ages. Sediment-filled basins of Triassic and Jurassic age (exact age is uncertain) occur within the crystalline basement throughout the coastal plain of Georgia and the Carolinas (Du Pont, 1980a). One of these, the Dunbarton Triassic Basin, underlies parts of Savannah River Plant.

##### L.3.3.1.2 Stratigraphy

Coastal Plain sediments in South Carolina range in age from Cretaceous to Quaternary; they form a seaward-dipping and thickening wedge of interstratified beds of mostly unconsolidated sediments. At the cooling-lake site, these sediments are approximately 400 meters thick (Siple, 1967). The base of the sedimentary wedge rests on a Precambrian and Paleozoic crystalline basement, which is similar to the metamorphic and igneous rocks of the Piedmont, and on the siltstone and claystone conglomerates of the down-faulted Dunbarton Triassic Basin. Immediately overlying the basement is the Tuscaloosa Formation of the Upper Cretaceous age, which is about 230 meters thick and composed of prolific water-bearing sands and gravels separated by prominent clay units. Overlying the Tuscaloosa is the Ellenton Formation, which is about 18 meters thick and consists of sands and clays interbedded with coarse sands and gravel. Four of the formations shown in Figure 3-5--the Congaree, McBean, Barnwell, and Hawthorn--comprise the Tertiary (Eocene and Miocene) sedimentary section, which is about 85 meters thick and consists predominantly of clays, sands, clayey sands, and sandy marls. The near-surface sands of the Barnwell and Hawthorn Formations are usually in a loose to medium-dense state; they often contain thin sediment-filled fissures (clastic dikes) (Du Pont, 1980a).

Quaternary alluvium has been mapped at the surface in floodplain areas. Soil horizons at the site are generally uniform and relatively shallow, about

1 meter deep. They are characterized by bleached Barnwell-Hawthorn sediments, which result in a light tan sandy loam. Section 3.4.2 and Appendix F present additional stratigraphic information.

### L.3.3.2 Seismology

#### L.3.3.2.1 Geologic structures

The Dunbarton Triassic Basin, which is similar to grabens in the Basin and Range Province in Nevada, underlies the Savannah River Plant at the L-Reactor site (Siple, 1967). Other Triassic-Jurassic basins have been identified in the Coastal Plain tectonic province within 300 kilometers of the site (Du Pont, 1980a; Popenoe and Zietz, 1977). The Piedmont, Blue Ridge, and Valley and Ridge tectonic provinces, which are associated with Appalachian mountain building, are northwest of the Fall Line. Several fault systems occur in and adjacent to the Piedmont and the Valley and Ridge tectonic provinces of the Appalachian system; the closest of these is the Belair Fault Zone, about 40 kilometers from the site. The U.S. Nuclear Regulatory Commission has determined that the Belair Fault is not capable within the meaning of 10 CFR 100 (Case, 1977). Studies sponsored by Georgia Power Company have shown that the faults postulated to occur near the southeastern boundary of the Savannah River Plant and about 40 kilometers farther southeast (Faye and Prowell, 1982) are not capable and that they might not exist (Georgia Power Company, 1982). There is no evidence of any recent displacement along any faults within 300 kilometers of the cooling-lake dam site (Du Pont, 1980a). In addition, no apparent association exists between local seismicity and specific faults near the Savannah River Plant, with the possible exception of the geophysically inferred faults (Lyttle et al., 1979; Behrendt et al., 1981; Talwani, 1982) in the meizoseismal area of the 1886 Charleston earthquake, which occurred approximately 145 kilometers from the Plant (Du Pont, 1982a).

Surface mapping and subsurface investigations in the L-Reactor region did not detect any faulting of the sedimentary strata or any other geologic hazards that would pose a threat to the reactor. Several surficial faults, generally less than 300 meters in length and with displacements of less than 1 meter, were mapped within several kilometers of the L-Reactor site. None of these faults is considered capable (Du Pont, 1980a).

#### L.3.3.2.2 Seismicity

Two major earthquakes have occurred within 300 kilometers of the proposed cooling-lake site: the Charleston earthquake of 1886, which had an epicentral Modified Mercalli Intensity (MMI) of X, was located about 145 kilometers away; and the Union County, South Carolina, earthquake of 1913, which had an epicentral shaking of MMI VII to VIII, was located approximately 160 kilometers away (Langley and Marter, 1973). An estimated peak horizontal shaking of 7 percent of gravity (0.07g) was calculated for the site during the 1886 Charleston earthquake (DOE, 1982b). No reservoir-induced seismicity is associated with Par Pond (Du Pont, 1982a).

Probabilistic and deterministic analyses commensurate with the criteria used by NRC (10 CFR 100) have established a design-basis earthquake acceleration of 0.20g for key seismic-resistant buildings at the Savannah River Plant. This acceleration is predicted to be exceeded only once in about 5000 years (Du Pont, 1982a). An evaluation of seismic forces would be included in the outlet works tower stability analysis; the joints would be designed to withstand seismic-induced movement.

#### L.3.4 Hydrology

##### L.3.4.1 Surface-water hydrology

###### L.3.4.1.1 Savannah River

The Savannah River Plant is drained almost entirely by the Savannah River, one of the major drainage networks in the southeastern United States (Langley and Marter, 1973). The peak historic flood between 1796 and 1983--10,190 cubic meters per second--corresponds to a stage of about 36 meters (DOE, 1982b). A domino-type failure of dams on the Savannah River above the Savannah River Plant would produce a flow of 42,500 cubic meters per second with a corresponding stage of 43.6 meters at the Plant (Du Pont, 1980a). Both of these flood stages are above the base of the proposed cooling-lake embankment (elevation 35 meters); however, only backwaters would reach the downstream embankment face, because a ridge on the west side of Steel Creek would shelter the embankment. The two nearest upstream reservoirs, Clarks Hill (completed in March 1953, with  $3.1 \times 10^9$  cubic meters of storage) and Hartwell (completed in June 1961, with  $3.1 \times 10^9$  cubic meters of storage), provide power, flood control, and recreational areas. These reservoirs and the New Savannah River Bluff Lock and Dam at Augusta, Georgia, have stabilized the river flow at Augusta to a yearly average of 288.8 cubic meters per second (Bloxham, 1979) and 295 cubic meters per second at Savannah River Plant. Russell Reservoir, which began filling in December 1983, will furnish  $1.2 \times 10^9$  cubic meters of storage to further stabilize Savannah River flows.

Since 1963, it has been the operating practice of the U.S. Army Corps of Engineers to attempt to maintain a minimum flow of 178.4 cubic meters per second below the New Savannah River Bluff Lock and Dam at Butler Creek (River Mile 187.4, near Augusta, Georgia) (COE, 1981b). During the 18-year period from 1964 to 1981 (climatic years ending March 31), the average of the lowest 7-consecutive-day flow each year measured at the New Savannah River Bluff Lock and Dam was 181 cubic meters per second (Watts, 1982), or about 2.3 cubic meters per second less than at Savannah River Plant (Ellenton Landing, River Mile 156.8). The 7-day, 10-year low flow of the river at SRP is calculated to be 159.0 cubic meters per second.

Figure 3-6 shows the mean monthly flow rates for the Savannah River measured at Augusta, Georgia, from January 1964 through September 1981. The highest flows occur in the winter and spring, and the lowest occur in the summer and fall. This figure also indicates long-term mean and 7-day, 10-year low flows at Ellenton Landing.

Duke Power Company has entered into an agreement with the City of Greenville, South Carolina, to provide an interbasin transfer of as much as 0.53 cubic meter per second in 1985 and 8.3 cubic meters per second by 2020 from Lake Keowee. The States of Georgia and South Carolina have asked the Corps of Engineers for permission to withdraw as much as 1.8 cubic meters per second (total) from Lake Hartwell. The Corps of Engineers maintains, in accordance with its agreement with Duke Power Company, that the interbasin transfer from Lake Keowee to the City of Greenville is legal provided it has no effect on the ability of the Corps to generate electric power at Lake Hartwell and Clarks Hill. The Corps of Engineers is presently assessing the requests by South Carolina and Georgia to withdraw water from Lake Hartwell. This assessment will include the ability of the Corps to maintain its navigation project below the New Savannah Bluff Lock and Dam and to meet its electric-power-generation requirements. It will also consider the effects of the interbasin transfer. Until the Corps of Engineers completes its assessment, it will maintain the flow below the New Savannah Bluff Lock and Dam at the current levels.

The 1979-1982 average temperature of the Savannah River 3 kilometers above the Savannah River Plant was 17.8°C, with a range of 1.5° to 25.0°C. Similarly, below the Plant, the average temperature was 18.4°C and the range was 6.5° to 26.0°C. Figure 3-7 shows monthly average daily-maximum temperatures above and below the Savannah River Plant for the period 1960-1970. As shown in that figure, June, July, August, and September are the warmest river temperature months. The average river temperature during these months is about 25 percent higher than the annual average river temperature. From June 1955 through September 1982, the river temperature at Ellenton Landing equaled or exceeded 28°C three times and equaled or exceeded 28.3°C once. During the February, March, April, and May fish-spawning season, the monthly average daily-maximum temperatures (and standard deviations) at Ellenton Landing were 8.7°C (1.0°C), 11.0°C (1.3°C), 15.4°C (1.3°C), and 18.8°C (1.6°C), respectively.

#### L.3.4.1.2 SRP streams and swamp

The SRP site is drained almost entirely by five principal systems (drainage areas are in parentheses): (1) Upper Three Runs Creek (490 square kilometers); (2) Four Mile Creek, including Beaver Dam Creek (90 square kilometers); (3) Pen Branch (90 square kilometers); (4) Steel Creek (90 square kilometers); and (5) Lower Three Runs Creek (470 square kilometers). These streams rise on the Aiken Plateau and descend 30 to 60 meters before discharging to the Savannah River. The sandy soils of the area permit rapid infiltration of rainfall; seepage from these soils furnishes the streams with a rather constant supply of water through most of the year (Langley and Marter, 1973).

The three streams that have received the greatest input of thermal effluent (Four Mile Creek, Pen Branch, and Steel Creek) flow into a contiguous swamp of about 10,240 acres (Du Pont, 1983b) that is separated from the main flow of the Savannah River by a 3-meter-high natural levee along the river bank. These streams generally flow as shallow sheets, with well-defined channels only where they enter the swamp and near breaches in the levee (Smith, Sharitz, and Gladden, 1981). The combined natural flow and reactor effluent discharges have a strong influence on water levels in the swamp during nonflood conditions.

The flow of water in the swamp is altered when the Savannah River is in flood stage (about 27.7 meters) with a flow rate of about 440 cubic meters per

second. Under flooding conditions, Four Mile Creek, Pen Branch, and Steel Creek discharge to the Savannah River at Little Hell Landing after crossing an offsite swamp (Creek Plantation Swamp). An analysis of the data from 1958 through 1980 indicates that on the average the Savannah River reaches flood stage at the Savannah River Plant 79 days or 22 percent of each year, predominantly from January through April. This result is in agreement with the results of a similar analysis performed by Langley and Marter (1973).

The L-Reactor site is drained by both Steel Creek and Pen Branch. Steel Creek was used from 1955 to 1968 to receive the reactor coolant discharge. The headwaters of Steel Creek rise near P-Area and flow southwesterly for about 7 kilometers, turn south for about 9 kilometers, and enter the Savannah River swamp about 3 to 5 kilometers from the river. A delta of about 100 acres surrounded by a partial tree-kill zone of another 180 acres has developed where the creek enters the swamp (Du Pont, 1983a). Beyond the delta, Steel Creek is joined by the flow from Pen Branch and some flow from Four Mile Creek before it discharges into the Savannah River near Steel Creek Landing (see Figure 3-2).

During the 1983 water year (October 1982 through September 1983), the flow of Steel Creek at Road B ranged between 0.28 and 3.96 cubic meters per second. The average flow for this period was 0.62 cubic meter per second. During the 4-month period from October 1983 to January 1984, the flow at Road B ranged from 0.19 to 4.39 cubic meters per second, and the average flow was 1.00 cubic meter per second. Of the average flow, about 0.45 cubic meter per second was discharged from P-Reactor at near-ambient temperatures (McAllister, 1983). Farther downstream at Cypress Bridge, about 2.8 kilometers below Road A, the average flow of Steel Creek during calendar years 1978 through 1980 was 1.36 cubic meters per second. During the 1983 water year, this flow ranged from 0.65 to 5.95 cubic meters per second and the average flow was 1.91 cubic meters per second. During the 4-month period from October 1983 to January 1984, this flow ranged from 1.13 to 5.55 cubic meters per second, with an average of 2.74 cubic meters per second. After subtracting the P-Reactor contribution, the natural flow of Steel Creek at Cypress Bridge is calculated to be about 0.91 cubic meter per second. Du Pont (1982b) estimated the natural flow of Steel Creek to be 1.0 cubic meter per second, based on drainage area considerations. Maximum daily flow rates (both natural storm runoff and with discharges from P-Reactor) were measured between 4.2 and 8.2 cubic meters per second during the past 8 years.

Steel Creek has had a varied history with respect to the release of reactor effluents. The release of thermal effluents into Steel Creek from L- and P-Reactors reached a peak of about 23 cubic meters per second in 1961. In 1963, P-Reactor effluents were diverted to Par Pond, and thermal discharges to the creek were reduced to about 11 cubic meters per second, about 1.3 times the maximum natural flow expected at Cypress Bridge after heavy rains. Since 1968, Steel Creek has received only infrequent and short-term inputs of thermal effluents (Smith, Sharitz, and Gladden, 1981, 1982a; Du Pont, 1982b). Between 1951 and 1972, the Steel Creek channel width increased more than three times due to effluent scour.

At the present time, several effluents from P-Reactor area normally flow into either Steel Creek or Meyers Branch. The effluents to Steel Creek consist of the process sewer outfall (0.45 cubic meter per second); infrequent cooling water from P-Reactor, and storm water outfall. The normal effluents to Meyers Branch include (1) overflow from ash settling/seepage basin (0.01 cubic meter

per second), (2) periodic overflow from the coal pile runoff basin, (3) non-process cooling water (0.02 cubic meter per second), and (4) storm water outfalls.

Figure L-16 shows recent water temperatures along Steel Creek at Cypress Bridge, about 2.8 kilometers below Road A. The figure shows the temperature ranges and averages of monthly grab samples taken during the period of July 1973 through December 1982.

Water samples were taken every 2 weeks from 7 locations along Steel Creek and Meyers Branch between November 2, 1983, and January 31, 1984 (seven samples from each location) and analyzed for several constituents. Figure L-17 shows the sampling locations; Table L-2 lists the chemical analyses.

#### L.3.4.1.3 Design floods on Steel Creek

The design floods for the 1000-acre lake were modeled by computer analysis, using the latest revision of the U.S. Army Corps of Engineers' HEC-1 program. In the applications to this project, the program computed the lake inflow hydrograph (flow rate vs. time), then "routed" this hydrograph through the lake to produce the lake outflow hydrograph and lake surface elevations throughout the storm. The input required to produce the inflow hydrograph included the rainfall hydrograph (rainfall amounts vs. time), drainage area, percent of the area which is impervious, and parameters which reflect the response time of the watershed and the infiltration capability of the pervious fraction of the watershed. The input required to route the inflow hydrograph through the lake included the initial lake elevation and the "stage-storage-discharge" characteristics of the lake (i.e., volume of storage and outflow rate for various lake elevations).

The standard project flood assumes a 4-day storm of 51 centimeters. The rainfall intensity varies throughout the event. The most intense 30-minute period produced 8 centimeters of rainfall. The characteristics of this storm are discussed in detail in Section L.2.3.1. This storm produced 37 centimeters of runoff (rainfall minus infiltration) and a peak inflow rate of 403 cubic meters per second. As this flood wave entered the lake the lake level rose while outflow was released through the principal outlet works at a much lower rate. The peak outflow rate was 29 cubic meters per second and the peak lake elevation was 59.4 meters, about 1.6 meters below the top of the embankment. As a result of the existence of the lake, flood damage to lower Steel Creek would be substantially reduced.

The probable maximum flood (PMF) is a measure of the results of the most intense storm that is meteorologically possible for an area. Its probability of occurrence is so low that no attempt was made to relate it to a recurrence interval. Despite its extremely low probability of occurrence, it was incorporated into the design bases in order to test the adequacy of the natural saddle which is to serve temporarily as the emergency spillway.

The storm which produced the PMF totaled 72 centimeters in 24 hours, with a peak 30-minute rainfall of 16.3 centimeters. The storm produced 57 centimeters of runoff, with a peak flowrate of 848 cubic meters per second. The peak lake outflow rate was 42 cubic meters per second while the lake elevation rose to

60.5 meters, 0.3 meters above the lowest point on the saddle but 0.5 meter below the top of the embankment.

About 12 cubic meters per second of the peak outflow would pass over the saddle to Pen Branch. The maximum average velocity of flow over the saddle would be 6 centimeters per second. This is a mild velocity for a grassed waterway, so little, if any, damage would occur. As in the case of the standard project flood, substantial flood-damage reduction downstream of the embankment would result from the lake's ability to attenuate the peak flow from 848 cubic meters per second to 42 cubic meters per second.

#### L.3.4.1.4 Surface-water use

Downstream from Augusta, Georgia, the Savannah River is classified by the State of South Carolina as a Class B waterway, suitable for agricultural and industrial use, the propagation of fish, and--after treatment--domestic use. The river upstream from the Savannah River Plant supplies municipal water for Augusta, Georgia, and North Augusta, South Carolina. Downstream, the Beaufort-Jasper Water Authority in South Carolina (River Mile 39.2) withdraws about 19,700 cubic meters per day (0.23 cubic meter per second) to supply domestic water for a population of about 51,000. The Cherokee Hill Water Treatment Plant at Port Wentworth, Georgia (River Mile 29.0), withdraws about 116,600 cubic meters per day (1.35 cubic meters per second) to supply a business-industrial complex near Savannah, Georgia, that has an estimated consumer population of about 20,000 (Du Pont, 1982b). Plant expansions for both systems are planned for the future.

The Savannah River Plant currently withdraws a maximum of 26 cubic meters per second (about 63 percent of the maximum pumping rate of 41 cubic meters per second) from the river, primarily for use as cooling water in production reactors and coal-fired power plants (Du Pont, 1982b). Almost all of this water returns to the river via SRP streams (Du Pont, 1981a). The river receives sewage treatment effluents from Augusta, Georgia, and North Augusta, Aiken, and Horse Creek Valley, South Carolina, and other waste discharges along with the heated cooling water from the Savannah River Plant via its tributaries. The cooling-water withdrawal and discharge rate of about 1.2 cubic meters per second for both units of the Alvin Vogtle Nuclear Plant is expected later in the 1980s (Georgia Power Company, 1974). The Urquhart Steam Generating Station at Beech Island withdraws approximately 7.4 cubic meters per second of once-through cooling water. Upstream, recreational use of impoundments on the Savannah River, including water contact recreation, is more extensive than it is near the Savannah River Plant and downstream. No uses of the Savannah River for irrigation have been identified in either South Carolina or Georgia (Du Pont, 1982b).

The water quality of the Savannah River is discussed in Chapter 4. Historic data demonstrate that the water quality of the river downstream of the Savannah River Plant is similar to the water quality upstream (Marter, 1970).